COMPARISON OF SELECTED CONSTRUCTION TECHNIQUES ON TWO BENDIXSEN-BUILT WOODEN SCHOONERS - NEPTUNE AND C. A. THAYER

By

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Although much is known about early wooden vessel construction in general, little is known of techniques used by specific shipyards on the Pacific Coast. When more than one vessel survives from the same builder, comparisons of construction techniques can be made and generalizations proposed. The purpose of this paper is to compare construction techniques on NEPTUNE and C.A. THAYER which were found by archaeologists to be identical.

Lumber was needed in great quantities quickly after the 1849 California gold rush, especially in San Francisco, the starting point to the gold fields. A large store of lumber was to be had in the Pacific Northwest forests. Due to the need for lumber and the changing wind patterns along the Pacific coastline, the wooden-hulled lumber schooner was developed and built by a variety of shipyards along the California coast.

One of these shipbuilders was Hans D. Bendixsen who operated his yard at Fairhaven near Eureka. A Dane born in 1842, Bendixsen started in Denmark as a shipwright's apprentice, took a job on board a ship bound for South America, and eventually sailed to San Francisco. There he worked in a shipyard until 1865 when he settled in Eureka to open his own shipyard. He relocated his yard at Fairhaven in

1875 where more room was available for expansion.[2] Under Bendixsen's ownership, the yard built 113 vessels by 1900 when Bendixsen sold out to a new owner.[3] He died two years later with a renowned reputation for shipbuilding. "Some of the finest vessels in the coasting fleet have been build by Bendixsen..."[4]

Today only two Bendixsen vessels remain. One is WAWONA, a three-masted lumber schooner berthed at the Northwest Seaport Museum in the State of Washington. She is a near sister ship to C.A. THAYER, a three-master under the jurisdiction of the U.S. Government, National Park Service, Golden Gate National Recreation Area in San Francisco, California.

Built in 1895, C.A. THAYER carried lumber from the Pacific Northwest "dogholes" to San Francisco, other cities, and to foreign ports until 1912. Later she served as a salmon packet until 1925, and finally as a codfisherman until 1950 when she made her last commercial voyage. In 1963 she became a floating example of her type at the Golden Gate National Recreation Area, National Maritime Museum at Hyde Street Pier. She was distinguished as a National Historic Landmark in 1966. She measures as follows: length, 156'; breadth, 36'; depth of hold, 11' 8"; gross tonnage, 452.29.[5]

In 1982 a shipwreck was discovered off of Fort Funston which turned out to be Bendixsen-built. The two-masted lumber schooner NEPTUNE was built in 1882 and wrecked in 1900. Measurements were: length, 106' 5"; breadth, 30'; depth of hold, 8' 7"; and gross tonnage, 184. Having gone aground due to a lull in the wind,

NEPTUNE dragged anchor, washing up on Ocean Beach on August 10, 1900. NEPTUNE's remains were positively identified from old photographs, newspaper articles, timber analysis and from structural comparisons with C.A. THAYER when a preliminary archaeological investigation was carried out in 1982 and certain measurements were taken.[6]

The three vessels were built of Douglas-fir, the principle wooden ship-building material on the Pacific Coast. It was found about 1860 to be an excellent replacement for the Eastern hardwoods which, until then, had to be transported around Cape Horn to the West. Douglas-fir has the capacity of keeping iron bolts from corroding, and allows for less scarph jointing due the great length of its timbers.[7]

Most shipyards did not draw or keep vessel plans, and a great many ship-building techniques were kept in the minds and/or personal notebooks of builders and their shipwrights. The Bendixsen yard was such a yard, so comparative analysis must suffice to obtain certain information.[8] Clues also can be obtained from publications such as, "The model of the C.A. THAYER and MAWEEMA [launched on 11-19-1895; length, 156'; breadth, 36'; depth of hold, 11' 8"; gross tonnage, 453.64] seems to be a favorite one as Mr. Bendixsen has the keel laid at his yard for a third schooner on the same lines."[9]

From comparative analysis performed in 1983 between fittings and timber connections on NEPTUNE and C.A. THAYER, a number of techniques were found to be identical. This paper will discuss in detail the specific techniques used by the Bendixsen yard on the

two vessels for fitting treenails, clinch bolts, and chainplates, and for connecting futtocks and planking. Four individuals were interviewed and three wooden ship-building texts were consulted; the results are outlined in the discussions that follow.

FASTENINGS

Treenails are cylindrical wooden pins that, when driven in, hold planks and timbers of a vessel together. The techniques used on both vessels were standard for ship-building. That is, the hole is bored slightly smaller than the diameter of the treenail, the treenail is either hand or machine-driven, and is lopped off at either end flush with the timber. A hardwood wedge is then driven in at either end across the diameter of the treenail to expand the ends for a tight fit.[10] Treenails on C.A. THAYER appear to be turned on a lathe and to be perfectly round as opposed to eight-sided.

Clinch bolts: "Steel or iron drift and clinch bolts are used to supplement treenails in the fastenings." They can be made of iron or bronze or yellow metal.[11] They could be done either hot or cold and a blacksmith was needed for the former.[12] "Where bolt heading machines are available, the iron may be heated and then headed to any desired shape."[13]

Clinch bolts are the standard type and fitted using standard techniques on both vessels. They are sent entirely through the timbers (as opposed to blunt bolts which are not) "and have their ends hammered

over, upset, riveted, or clinched over iron rings called clinch rings."[14] Then the head is "upset" or peened out so that it swells out and makes a rounded head flush with the clinch ring.[15] (See illustration in Davis, p. 59.)

JOINTS

Plank connections: It is agreed by all that butt joints must not be placed next to each other in the planking, but rather staggered so that a weakness will not develop in the planking. Also butt joints must be placed on top of frames. Otherwise they are "floating free", creating an unsound condition in the hull.[16] There are a number of combinations of fastenings that can be used at the butt ends. "It is well to bear in mind this important fact--treenail fastenings resist transverse strains better than metal, but the metal will better resist direct separation strains. It therefore is apparent that a wise combination of the two kinds of fastenings is most desirable."[17] The combinations used on C.A. THAYER is unknown.

Futtock connections: Those interviewed for this paper said that the standard procedure was employed for futtock construction and connection. To quote from Davis: "These pieces are laid around to the required shape in two layers, one layer overlapping the joints of the other."[18] (See attached illustration from Desmond.)[19]

Regarding fastenings Curtis states, "Frame fastening is clustered about the butt...six fastenings to the butt [three on either end], but this number may be more or less, according to the size of the frame and the location of the butt in the frame."[20]

CHAINPLATES

"Chainplates are flat or round iron bars fitted in the wake of the various masts; the lower end being bolted to the topside of the vessel; they serve as supports of the lower rigging and backstays."[21] Desmond describes channels as supports for chainplates. C.A. THAYER has none and her chainplates are bolted with three bolts instead of Desmond's two.[22] Harrison Dring stated that the bolts are specially made with rectangular holes cut in the inner hull end of the bolts. A steel wedge is pounded through the hole. The bolts and chainplates then can be removed to renew the planking. Dring stated also that chainplates are always attached to frames.[23] C.A. THAYER's chainplates are flat, have the special steel wedge pounded through the bolt ends, and are attached to the frames. (See attached illustration).

From the above study it can be concluded tentatively that little variation occured in techniques used on the basic structure or foundation of a vessel - the hull. Davis said, "One half of the secret of good wooden ship building is in making perfect joints in all the pieces of wood that are fitted together; the other half is in properly fastening the pieces together."[24] It is one matter to experiment with the cabin top, and another with the very foundation of a vessel. The "tried and true" appears to have prevailed when it

came to building the body of a vessel.

It is hoped through analysis such as the above that techniques of old wooden ship-building will become documented so that the art is not lost totally. In our mechanized society we can lose sight of commonplace techniques that did not require total dependence on sophisticated machinery. Techniques of the past can lend a fresh view to today's techniques, and perhaps be useful in ways we may not yet be aware of. Such knowledge adds insight into the process of thinking and the social structure influencing thought. For example, did they do it that way because "that's the way my father (teacher, etc.) taught me" or because it was the only way that really worked?

While it cannot be concluded that we now know routine techniques employed on all lumber schooners from Bendixsen's shipyard, we do know techniques common between two such vessels, and have the capacity to investigate and compare techniques with yet a third vessel, the WAWONA in Washington. If it were not for the discovery and archaeological investigation of the shipwreck NEPTUNE, our knowledge of ship-building techniques at the Bendixsen yard would not be as extensive as it now is.

Maritime archaeological remains can bring to light aspects of our culture only guessed at previously, and can be the substantial evidence needed for drawing conclusions instead of limiting ourselves to theories. The remains themselves don't lie; we only have to dig for them.

Notes

[1]James P. Delgado, Documentation and Identification of the Remains of the 1882 Schooner NEPTUNE (San Francisco: Golden Gate National Recreation Area, [1983]),Appendix V.

[2]Eureka Times Standard, 6 January, 1975, p. 5.

[3]Jack McNairn and Jerry MacMullen, Ships of the Redwood Coast (Stanford, Calif.: Stanford University Press, 1945), p. 79.

[4]Wallace E. Martin, comp., Sail and Steam on the Northern California Coast, 1850 to 1900 (San Francisco: National Maritime Museum Assoc., 1983), p. 140.

[5]Roger Olmsted, C.A. THAYER and the Pacific Lumber Schooners (Pasadena, Calif.: Ward Ritchie Press, 1972), p. 1.

[6]Delgado, NEPTUNE Report.

[7]Henry Hall, Report on the Ship-Building Industry of the United States, p. 131.

[8]Ibid., p. 132.

[9]Martin, Sail and Steam, p. 254.

[10]Charles G. Davis, The Building of a Wooden Ship (Philadelphia: U.S. Shipping Board Emergency Fleet Corp., 1918), p. 57.

[11]Ibid.

[12]Interview with Ron Oakes (Supervisory Shipwright at the Golden Gate National Recreation Area), 17 July, 1984.

[13]Davis, Building of a Wooden Ship, p. 57.

[14]Ibid.

[15]Ron Oakes interview.

[16]Ibid.

[17]Charles Desmond, Wooden Ship-Building (New York: Rudder Pub. Co., 1919), p. 59.

[18]Davis, Building of a Wooden Ship, p. 17.

[19]Desmond, Wooden Ship-Building, p. 53.

[20]W.H. Curtis, The Elements of Wood Ship Construction (New York: McGraw-Hill, 1919), p. 52.

[21]Capt. H. Paasch, Illustrated Marine Encyclopedia of 1890 (Watford, Herts, England: Argus Books, 1890), p. 11.

[22]Desmond, Wooden Ship-Building, p. 130.

[23]Interview with Harrison Dring (retired Marine Maintenance Foreman from the Golden Gate National Recreation Area), 19 July, 1984.

[24]Davis, Building of a Wooden Ship, p. 57.

AUTHOR: CHARLES G. DAVIS (PHILA.: U.S. SHIPPING BOARD EMERGENCY FLEET CORP., 1918).

splitting the grain of the wood. These holes are from 1/8 to 1/16 inch smaller than the fastenings used.

The holes in clinch rings should be *chamfered* or countersunk, at about 10 to 12 degrees from the vertical, so that the bolt end, which should extend about one-half its diameter above the ring when ready to clinch, may be swelled out by hitting it smartly several blows on the end with a round-faced top maul and finishing it up to fit snugly in the countersink with a round or ball-peen heavy machinist's hammer. This expands the bolt end, *upsets* it as it is termed, so that the bolt swells out and fills the countersunk hole in the clinch ring. The upsetting of the head of the bolt is the most important feature of this method of fastening. As the strain put upon the timber tends to draw the bolt out, the head wedges down into the clinch ring. The broad, flat surface of the clinch-ring has sufficient area bearing on the wood to prevent the pressure of the bolt from forcing the ring into the wood and becoming loose enough to let the fastened timbers open apart. Each bolt should hold its own share of the pull for in unity there is strength. If all the bolts pull equally there will be no give to the structure.

After swelling the *neck* of the bolt in the ring, a rounded head is made on it by hammering around the edge of the bolt with a flat-faced top maul, sledge, or an air hammer. Many beginners simply smash away on a bolt regardless of how they mash the end of the iron as long as they drive it into the wood. This is not fastening the

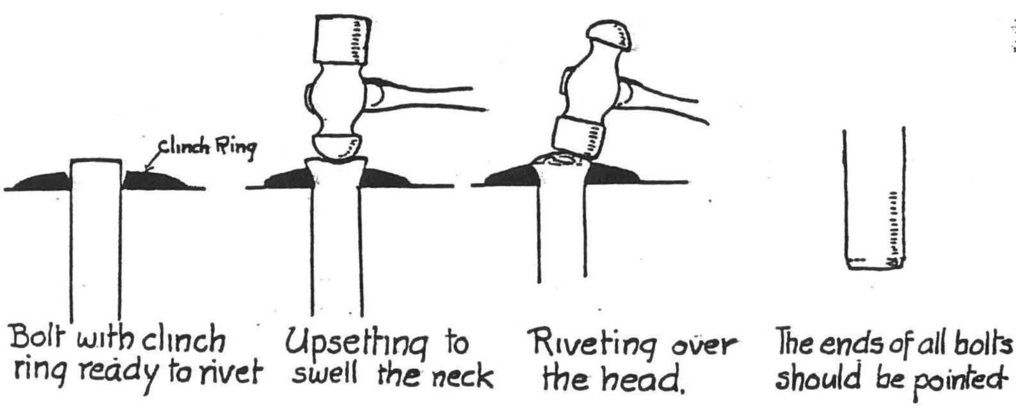

Fig. 57—Upsetting and riveting bolts.

ship—it may split the end of the iron so that its top looks like a cauliflower, but all the split ends do not make for strength. If a slight crack starts in the burr or turned-over edge of an iron bolt, the cracked spot should be hammered so as to compress and close it, making a smooth button head, and thus prevent its opening further. If you keep on hammering on the center, the crack will continue to grow larger.

All bolts should have their ends slightly pointed by hammering the sharp edges on the end so that they will follow the hole and push the wood aside, and not cut a shaving of wood ahead of them.

Clinch-rings should be forged from iron or steel, punched out of steel plates, or made out of malleable iron. A properly made clinch-ring, punched out of mild steel, will stand being bent over double without breaking.

term means the measurement of side on which the mould of shape of frame is placed.

Timber and space means the longitudinal space, or room, occupied by the timber of one frame added to the space between it and the next frame.

On Fig. 28 I show a transverse view of an assembled square frame, each piece of which is identified.

Beginning at the lower (keel) end of a frame I will describe each piece and explain how the various pieces are shaped and fastened together.

$8k^1$. *The Floor or Floor Timber*

This is the name of the piece of timber that crosses keel and serves to tie a frame on one side of keel with one on the other. On the illustration the floor is clearly marked.

The floors of the midship frame usually, in flat-floored ships, extend out to about one-fourth the breadth on each

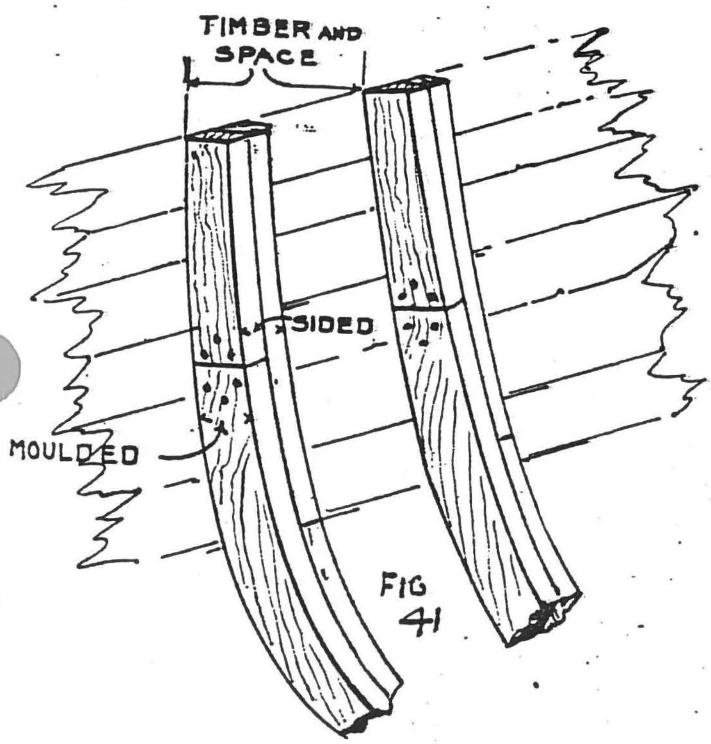

FIG 41

side of keel, but it must be remembered that if the floors are *doubled* (two floors placed alongside of each other) each will have a long and a short arm, the long arm of one floor being on side of keel that the short arm of adjacent one is. The reason for this is explained in description of frame timbers.

Floors are secured to keel with bolts, and if notched over keel their lowest points must exactly reach to bearding line of rabbet. The distance from bearding line of rabbet of keel to the upper part of floors, at their center line, is called the cutting down, or throating.

Dimensions of floors and their fastenings are given in Tables 3b and 3d.

$8k^2$. *The Frame Timbers*

The pieces of timber of which a frame is composed must be disposed in such a manner that they can be fastened together securely. This is done by shifting the butts and bolting the pieces together in the manner illustrated on Figs. 28 and 42a and explained below.

The floor on illustration is a double one, the dash line marked near keel across it indicating the end of a short arm, and the full line a little further out indicating end of a long arm.

The first futtock is butted against the end of short arm of floor and the upper end of this futtock extends to dotted line next above the full line that indicates end of long arm of floor. This permits lower portion of first futtock to be bolted to portion of long-arm floor that extends beyond the short arm of adjacent floor. The lower end of second futtock butts against long-arm end of floor and upper end of this futtock extends some distance above upper end of first futtock. The lower end of second futtock is fastened to portion of upper end of first futtock that extends beyond end of long arm of floor. In this manner each succeeding futtock overlaps and is bolted to the one below, and thus any short grain of wood at the end of a futtock is strengthened by the long grain of piece that overlaps it. On illustration the even numbered futtocks are marked for identification, and location of odd numbered ones is indicated by dash lines and numbers only.

Bolts are used to fasten the futtocks to floor arms and to each other, and if maximum strength is desired round coaks are inserted between the overlapping portions of futtocks.

All fastenings of futtocks should be located in positions that will keep them clear of knee and waterway fastenings, and if filling frames are to be used the heads and ends of bolts that are located where filling frames will be must be countersunk flush with surface of wood.

$8k^3$. *Filling Frames*

This is the name given to short frames located between the frames proper and extending from keel to about the turn of bilge. Their use is to strengthen the transverse bottom framing of vessel, but originally they were used in conjunction with caulking to make the whole of bottom of a vessel's transverse framing watertight.

The old method of using filling frames was to make these frames extend from keel to orlop deck location and to completely fill spaces between frames proper. Thus the whole of bottom and bilges of a vessel was made one solid mass of wood, and when the seams between the various frames and filling frames were caulked with oakum the whole bottom framing of vessel was made watertight. Construction of this kind requires a very large amount of material, and the weight of a vessel constructed in this manner is much greater than that of a vessel constructed in accordance with modern ideas of what is proper and necessary. In present-day construction of large vessels one filling frame, or at most two,

FROM CHARLES DESMOND'S BOOK

FROM: CHARLES DESMOND, WOODEN SHIP-BUILDING
(NEW YORK: RUDDER PUB. CO., 1919.), P. 130.

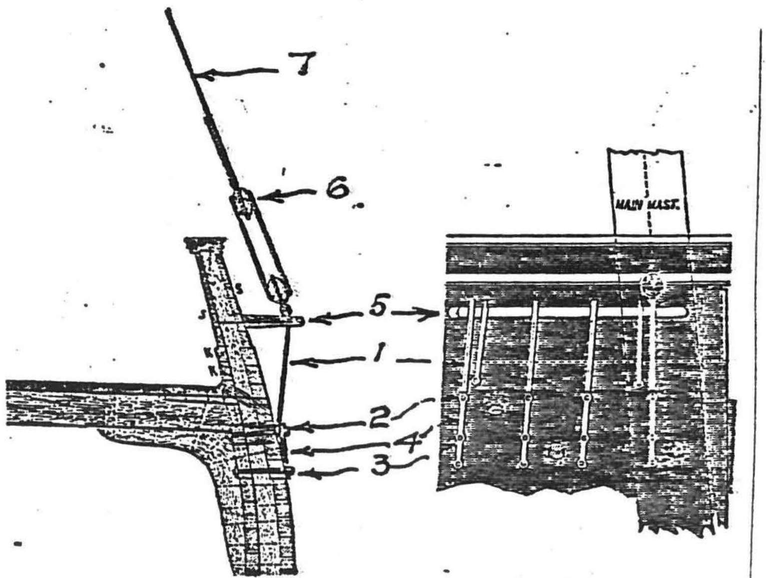

Fig. 118. Chain Plates and Channels

1. CHAINPLATE
2. CHAINPLATE BOLT
3. PREVENTER BOLT
4. PREVENTER PLATE
5. CHANNEL OVER WHICH CHAINPLATE IS LED
6. DEADEYE
7. RIGGING (STANDING)

Martin, Wallace E. Sail and Steam on the Northern California Coast: 1850 to 1900. San Francisco: National Maritime Museum Association, 1983.
A "diary of vessels built in the coves and harbors of California" taken from newspaper articles and other publications of the time. Included are launchings, shipwrecks, and other events about ships.

Olmsted, Roger. C.A. THAYER and the Pacific Lumber Schooners. Pasadena, Calif.: Ward Ritchie Press, 1972.
General information on history of C.A. THAYER.

Paasch, Capt. H. Illustrated Marine Encyclopedia. Watford, Herts, England: Argus Books, 1890.
Definitions of vessel parts with diagrams and illustrations.
A necessity!

Interviews were conducted with the following employees of the Golden Gate National Recreation Area:
Harrison Dring. Retired Marine Maintenance Foreman.
Karl Kortum. Chief Curator of the National Maritime Museum.
Ron Oakes. Supervisory Shipwright.
Dave Houck. Shipwright.